What is claimed is:

1. An apparatus for separation of a vapor or liquid mixtures comprising a plurality of components using a plurality of distillation columns (a first column to an n^{th} column) constructed in a cascade comprising:

introduction conduits which connect the bottom of a k^{th} column ($1 \leqq k \leqq (n-1)$) or an outlet of a reboiler provided in the vicinity of the bottom of the k^{th} column to the top of a $(k+1)^{th}$ column, an inlet of a condenser provided in the vicinity of the top of the $(k+1)^{th}$ column, or the middle section of the $(k+1)^{th}$ column; and

return conduits which connect an outlet of the condenser of the $(k+1)^{th}$ column to an inlet of the reboiler provided in the vicinity of the bottom of the k^{th} column, the bottom of the k^{th} column, or the middle section of the k^{th} column.

2. An apparatus for separation of a vapor or liquid mixture comprising a plurality of components using a plurality of distillation column (a first column to an n^{th} column) constructed in a cascade comprising:

introduction conduits which connect the bottom of a k^{th} column ($1 \leqq k \leqq (n-1)$) or an outlet of a reboiler provided in the vicinity of the bottom of the k^{th} column to the top of a $(k+1)^{th}$ column, an inlet of a condenser provided in the vicinity of the top of the $(k+1)^{th}$ column, or the middle section of the $(k+1)^{th}$ column; and

return conduits which connect the top of the $(k+1)^{th}$ column, or the inlet of the condenser provided in the vicinity of the top of the $(k+1)^{th}$ column to the bottom of the k^{th} column or the middle section of the k^{th} column via a blower.

3. An apparatus according to one of claims 1 and 2, wherein at least one of the distillation columns is a packed column in which structured packing (promoting-fluid-dispersion type structured packing or non-promoting-fluid-dispersion type structured packing) is used, or a wetted wall column.

4. An apparatus according to one of claims 1 and 2 comprising:

an isotope scrambler;

an extraction conduit which connects at least one section of said apparatus to an inlet of the isotope scrambler; and

a return conduit which connects at least one section of said apparatus to an outlet of the isotope scrambler.

5. An apparatus according to one of claims 1 to 4, comprising:

a hydrogenation device at a stage after the n^{th} column.

6. A method of enrichment of oxygen isotopes in which an oxygen starting material containing heavy oxygen isotopes is enriched by means of a cascade process using a plurality of distillation columns (a first column to an n^{th} column) comprising:

supplying at least a part of the vapor from the bottom of a k^{th} ($1 \leqq k \leqq (n-1)$) column or an outlet of a reboiler provided in the vicinity of the bottom of the k^{th} column to the top of a $(k+1)^{th}$ column, an inlet of a condenser provided in the vicinity of the top of the $(k+1)^{th}$ column, or a middle section of the $(k+1)^{th}$ column;

returning at least a part of the liquid from the top of the $(k+1)^{th}$ column or an outlet of the condenser of the $(k+1)^{th}$ column to an inlet of a reboiler of the k^{th} column, the bottom of the k^{th} column, or the middle section of the k^{th} column; and thereby

carrying out enrichment in at least one type of oxygen molecule of $^{16}O^{17}O$, $^{16}O^{18}O$, $^{17}O^{17}O$, $^{17}O^{18}O$, and $^{18}O^{18}O$ which contain heavy oxygen isotopes.

7 A method of enrichment of oxygen isotopes in which an oxygen starting material containing heavy oxygen isotopes is enriched by means of a cascade process using a plurality of distillation columns (a first column to an n^{th} column) comprising:

supplying at least a part of the vapor from the bottom of a k^{th} ($1 \leqq k \leqq (n-1)$) column or an outlet of a reboiler provided in the vicinity of the bottom of the k^{th} column to the top of a

$(k+1)^{th}$ column, an inlet of a condenser provided in the vicinity of the top of the $(k+1)^{th}$ column, or a middle section of the $(k+1)^{th}$ column;

pressurizing at least a part of a vapor drawn off from the top of a $(k+1)^{th}$ column or a vapor from an inlet of the condenser of the $(k+1)^{th}$ column by means of a blower, and then returning said vapor to the bottom of the k^{th} column or the middle section of the k^{th} column, and thereby

carrying out enrichment in at least one type of oxygen molecule of $^{16}O^{17}O$, $^{16}O^{18}O$, $^{17}O^{17}O$, $^{17}O^{18}O$, and $^{18}O^{18}O$ which contain heavy oxygen isotopes.

8. A method of enrichment of oxygen isotopes comprising:

subjecting an oxygen isotope enriched material enriched by means of a method of enrichment according to one of claims 6 and 7 to oxygen isotope scrambling to obtain an enriched product having an even higher concentration of at least one type of said oxygen molecules which contain heavy oxygen isotopes.

9. A method of enrichment of oxygen isotopes comprising:

subjecting an oxygen isotope enriched material enriched by means of a method of enrichment according to one of claims 6 and 7 to oxygen isotope scrambling to obtain an enriched material having a higher concentration of at least one type of said oxygen molecules which contain heavy oxygen isotopes; and

obtaining an enriched product having an even higher concentration of at least one type of said oxygen molecules which contain heavy oxygen isotopes by means of conducting a method of enrichment according to one of claims 6 and 7 again on said enriched material.

10. A method of producing heavy oxygen water comprising:

obtaining an enriched material which has been enriched in at least one component from oxygen molecules which contain heavy oxygen isotopes by means of cryogenic distillation of an oxygen starting material which contains heavy oxygen isotopes using an apparatus according to one of claims 1 and 2;

obtaining water containing heavy oxygen water corresponding to said enriched material by adding hydrogen to said enriched material; and thereafter,

further enriching said heavy oxygen water using an apparatus according to one of claims 1 and 2.

11. A method of producing heavy oxygen water in which a water starting material containing heavy oxygen water is enriched by means of a cascade process using a plurality of distillation columns comprising:

supplying at least a part of the water vapor from the bottom of a k^{th} ($1 \leqq k \leqq (n-1)$) column or an outlet of a reboiler provided in the vicinity of the bottom of the k^{th} column to the top of a $(k+1)^{th}$ column, an inlet of a condenser provided in the vicinity of the top of the $(k+1)^{th}$ column, or a middle section of the $(k+1)^{th}$ column,

introducing at least a part of the water from the top of the $(k+1)^{th}$ column or an outlet of the condenser of the $(k+1)^{th}$ column into an inlet of a reboiler of the k^{th} column, the bottom of the k^{th} column, or the middle section of the k^{th} column, and thereby

carrying out enrichment in at least one type of heavy oxygen water of $H_2{}^{17}O$, $H_2{}^{18}O$, $D_2{}^{17}O$, $D_2{}^{18}O$, $DH^{17}O$ and $DH^{18}O$ which contain heavy oxygen isotopes.